# Conditions for designing single-mode air-core waveguides in three-dimensional photonic crystals

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We present a general procedure that allows the design of single-mode air-core waveguides in three-dimensional photonic crystals. The procedure involves analyzing the modal profile of the bandedge mode in the perfect crystal, identifying the regions of maximal electric-field intensity and placing the air defects to enclose these regions.[1]

As an illustration, we present a detailed design of air-core waveguides in a recently proposed silicon body-center-cubic crystal structure, compatible with the holographic fabrication technique, that possesses a 25% complete bandgap between the 2nd and the 3rd band. We show that the waveguiding bandwidth reaches 102 nm centered at a wavelength of $1.5\,\mu m$. As a second example, we consider air-core waveguides in an inverted opal photonic crystal made of interpenetrating air spheres, coated with Ge. Here we focus on the complete gap between the 8th and the 9th band, since a projected band analysis reveals that it is difficult to use the large lower incomplete gap for guiding purposes. In that case, we find a 113 nm waveguiding bandwidth centered at a wavelength of $1.5\,\mu m$.[2]

[1] V. Lousse, J. Shin, and S. Fan, *Appl. Phys. Lett.*, **89**, 161103 (2006).
[2] V. Lousse, and S. Fan, *Opt. Express*, **14**, 866 (2006).